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# **EUROPEAN PATENT APPLICATION**

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⑦ Applicant: **BS & B SAFETY SYSTEMS, INC.**  
7455 East 45th Street  
Tulsa Oklahoma(US)

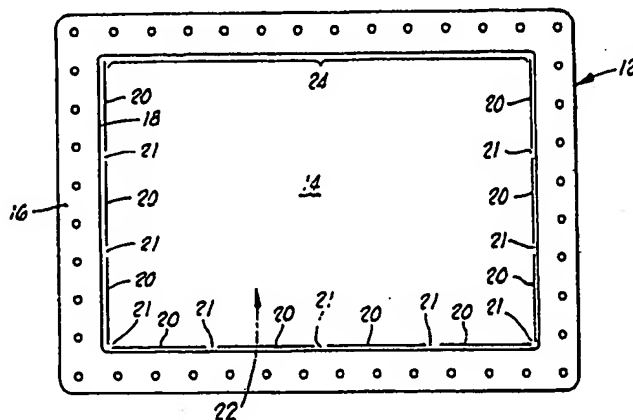
⑦ Inventor: **Short, III, Edward H.**  
5818 South Pittsburg  
Tulsa, Oklahoma 74135(US)  
Inventor: **Rooker, Mitchel L.**  
1015 McKinley  
Sand Springs, Oklahoma 74063(US)  
Inventor: **Sawyer, E. Bernel**  
4945C South, 76th East Avenue  
Tulsa, Oklahoma 74145(US)

⑦ Representative: **Allen, William Guy Fairfax et al**  
**J.A. KEMP & CO. 14 South Square Gray's Inn**  
London WC1R 5LX(GB)

⑤ Pressure relief panel assembly.

⑤ A pressure relief panel assembly including a single rupture panel (12) is provided. The rupture panel includes a domed portion (14) connected to a peripheral flat flange portion (16) and has at least one slit (20) formed therein defining a hinged blow-

out part (22). The hinged blow-out part is connected to the remaining part of the rupture panel by an unslit hinge area (24) and a plurality of rupture tabs (21).



**FIG. 3**

The present invention relates to pressure relief panel assemblies.

Pressure relief panel assemblies, sometimes referred to as explosion panels are used to provide instantaneous low pressure relief to enclosures, such as tanks, food processing vessels and bag houses, which are subject to rapid fluid pressure build-ups. For example, due to the collection of dust in bag houses, there is a constant risk of explosion. In order to prevent such explosions from causing severe damage to the bag house enclosure, equipment and personnel, one or more pressure relief panel assemblies are connected thereto which instantaneously rupture at relatively low pressures and provide large pressure relief openings through which pressurized burning gases are vented.

Known pressure relief panel assemblies have heretofore included composite rupture panels, i.e. panels made up of a number of parts which must rupture or open when pressurized fluid is relieved therethrough. For example, US-A-4498261 discloses a low pressure venting panel comprising a rupture member having a plurality of slits and apertures therein and a sealing membrane bonded to one side thereof. Both the rupture member and sealing membrane must rupture before opening of the panel is achieved.

US-A-4821909 discloses a pressure relief panel comprising a stainless steel member having slots which form lines of weakness therein and a sheet of plastic material bonded to one side of the stainless steel member.

Such prior composite rupture panels have tendencies to rupture at pressure differentials higher than expected in situations where extremely rapid pressure rises occur, e.g. an explosion. That is, because more than one part of the composite panel must rupture in order for the panel to open, the pressures required to rupture the individual parts can be additive rather than only that pressure which is required to rupture the strongest part.

In a number of applications, pressure relief panels are subjected to pressure-vacuum cycles, some as often as two or three cycles per minute. Such pressure-vacuum cycles cause the panels to flex which in turn often rapidly deteriorates composite panels causing them to fail prematurely.

According to the present invention there is provided a pressure relief panel assembly comprising a rupture panel having a domed portion connected to a peripheral flat flange portion and having at least one slit formed therein defining a hinged blow-out part in said rupture panel, said hinged blow-out part being connected to the remaining part of said rupture panel by an unslit hinge area and by a plurality of rupture tabs which rupture and allow said hinged blow-out part to open when a

pressure differential of predetermined magnitude is exerted on said rupture panel; a pair of gasket members positioned on opposite sides of said peripheral flange portion of said rupture panel and extending inwardly over said at least one slit whereby said at least one slit is sealed by said gasket members when fluid pressure differentials are exerted on said panel; and inlet and outlet complementary rupture panel support members adapted to be sealingly clamped together with said peripheral flange portion of said rupture panel and said gasket members therebetween, and adapted to be sealingly connected over a pressure relief vent.

Such an assembly may thus comprise a single rupture panel which reliably ruptures and opens at a predetermined pressure differential, and which can withstand pressure-vacuum cycles without premature deterioration or other adverse effect.

The slit or slits defining the hinged blow-out part in the panel are preferably positioned in or closely adjacent to the peripheral flat flange portion of the panel whereby the gasket members extend inwardly from the flat flange portion only a short distance.

Inlet and outlet complementary rupture panel support members are provided adapted to be sealingly clamped together with the peripheral flange portion of the rupture panel and the gasket members therebetween, and adapted to be sealingly connected over a pressure relief vent.

In order that the invention may more readily be understood, the following description is given, merely by way of example, reference being made to the accompanying drawings, in which:-

Figure 1 is a plan-view of the inlet side of one embodiment of pressure relief panel assembly of the present invention;

Figure 2 is a cross-sectional view taken along line 2-2 of Figure 1;

Figure 3 is a plan-view of the inlet side of the rupture panel of the assembly illustrated in Figures 1 and 2;

Figure 4 is an enlarged partial cross-sectional view taken along line 4-4 of Figure 1;

Figure 5 is a cross-sectional view similar to Figure 2, but illustrating the assembly after rupture and opening of the rupture panel thereof;

Figure 6 is a plan view of the inlet side of an alternative embodiment of the rupture panel of the present invention;

Figure 7 is a plan-view of the inlet side of another embodiment of the rupture panel of the present invention;

Figure 8 is a plan view of the inlet side of a still further embodiment of the rupture panel of the present invention;

Figure 9 is a plan view of the outlet side of yet

another embodiment of the rupture panel of the present invention; and

Figure 10 is an enlarged partial cross-sectional view of a pressure relief panel assembly of the present invention including the rupture panel illustrated in Figure 9.

The present invention provides an improved pressure relief panel assembly, which includes a single domed rupture panel having at least one slit formed therein defining a hinged blow-out part in the rupture panel. The term "slit" is used herein to mean an elongated cut of narrow thickness formed in the rupture panel and extending therethrough. The term "hinged blow-out part" is used herein to mean a portion of the rupture panel defined by one or more slits therein which includes an unslit area which functions as a hinge. That is, upon rupture the blow-out part is moved away from the remaining part of the rupture panel but bends at and remains attached to the remaining part at the hinge formed by the unslit area. The term "rupture tab(s)" is used herein to mean the unslit portions of the rupture panel between intermittent slits or separate rupturable connectors attached between the blow-out part and the remaining part of a rupture panel. The rupture tabs have predetermined strengths whereby they tear or otherwise rupture and allow the blow-out part to open when a pressure differential of predetermined magnitude is exerted thereon.

Referring first to Figures 1 - 5, the assembly 10 illustrates a rupture panel 12 (shown separately in Figure 3) which has a domed portion 14 connected to a peripheral flat flange portion 16 by a transition connection 18. The rupture panel 12 and the assembly 10 are preferably rectangular as illustrated in the drawings, but could have other shapes e.g. circular, square, etc. As best shown in Figures 3 and 4, the rupture panel 12 includes intermittent slits 20 formed therein and positioned adjacent to sections of the flat flange portion 16 of the rupture panel 12. The intermittent slits 20 define three sides of the substantially rectangular blow-out part 22 with the fourth unslit side (designated by the numeral 24 in Figure 3) comprising the hinge by which the hinged blow-out part 22 is connected to the remaining part of the rupture panel 12. The unslit portions of the rupture panel 12 between the intermittent slits 20 define rupture tabs 21 in the rupture panel 12.

Gasket members 26 and 28 are positioned on opposite sides of the peripheral flange portion 16 of the rupture panel 12 and extend inwardly over the intermittent slits 20. The gasket members 26 and 28 are formed of highly weather and chemical resistant flexible material, e.g. a silicone based material, and seal the intermittent slits 20 when fluid pressure differentials are exerted on the rupture panel 12. The term "pressure differential" is

used herein to mean the difference in fluid pressures exerted on the inlet and outlet sides of the rupture panel 12, e.g. a pressure of 1-36 bar on the inlet side and atmospheric pressure on the outlet side produces a pressure differential of 0.36 bar. The term "reverse pressure differential" is used herein to specifically describe the situations where the pressure on the outlet side of the rupture panel is greater than the pressure on the inlet side, e.g. atmospheric on the outlet side and a vacuum on the inlet side. If desired, the gasket members 26 and 28 may be bonded to the rupture panel.

A complementary inlet and outlet rupture panel support member 30 and 32 are positioned adjacent the gasket members 26 and 28, respectively, and the peripheral flat flange portion 16 of the rupture panel 12 and the gasket members 26 and 28 are sealingly clamped between the inlet and outlet support members 30 and 32 by a plurality of studs and nuts 34, with the studs extending through complementary openings in the peripheral flange portion 16 of the rupture panel 12, the gasket members 26 and 28 and the support members 30 and 32. As best shown in Figure 2, the supporting surface of the inlet support member 30 extends inwardly past the transition connection 18 of the rupture panel 12 so that the transition connection 18 is supported thereby during reverse pressure differentials.

In operation of the assembly 10, the inlet rupture panel support member 30 is sealingly connected to a complementary vent opening, such as by welding, provided in a vessel, bag house or other enclosure to be protected. As shown best in Figure 2, the rupture panel 12 is positioned within the assembly 10 whereby the concave side of the rupture panel 12 faces the inlet support member 30. When the enclosure to which the assembly 10 is attached contains a positive fluid pressure, the resultant pressure differential is exerted on the concave side of the rupture panel 12. Because the gasket member 26 extends inwardly over the intermittent slits 20, the pressure differential exerted on the rupture panel 12 forces the gasket member 26 against the rupture panel 12 whereby the slits 20 are sealed thereby and pressurized fluid is prevented from passing therethrough. When a reverse pressure differential is exerted on the rupture panel 12, the gasket member 28 is forced against the rupture panel 12 whereby the slits 20 are sealed thereby. During a reverse pressure differential and because of the concave-convex shape of the domed portion 14 of the rupture panel 12, the domed portion 14 is in compression and the transition connection 18 of the rupture panel 12 is supported by the surface of the support member 30 adjacent thereto. Such support of the transition connection when the domed portion 14 is in compression

prevents the reversal of the rupture panel 12.

The thickness of the material of which the rupture panel is formed and the distance between the slits 20 determine the strengths of the rupture tabs 21 and the pressure differential required to cause their rupture and the opening of the hinged blow-out part 22. Such pressure differential is determined by well known trial and error manufacturing techniques.

When a pressure differential is exerted on the assembly 10, i.e. a positive pressure is exerted on the concave side of the rupture panel 12, the rupture panel is placed in tension and tensile shearing forces are exerted on the rupture tabs 21. When the pressure differential reaches the predetermined magnitude at which the strengths of one or more of the rupture tabs 21 are exceeded, rupture occurs and the blow-out part 22 bends outwardly from the remaining part of the rupture panel 12 at the hinge area 24 as shown in Figure 5. The opening of the hinged blow-out part 22 relieves fluid pressure from the enclosure to which the assembly 10 is attached, and because the rupture panel 12 and blow-out part 22 thereof are large, such pressure relief is substantially instantaneous.

One or more of the rupture tabs 21 can be made to control the opening of the rupture panel 12 by making the ends of the slits 20 defining such rupture tabs closer together than the ends of the slits defining other rupture tabs. Also, by selecting the rupture tab(s) 21 under the greatest load as the tab(s) which control the opening of the rupture panel 12, the other tabs can be of reduced strength which allows the rupture panel 12 to open fully more rapidly.

The number and configuration of the slits 20 can be varied and apertures can be formed at the ends of the slits in order to provide better control of the pressure differential at which the rupture tabs 21 rupture. Apertures can also be formed in the solid rupture tab portions of the panel 12 to reduce their strength if desired.

Referring to Figure 6, a rupture panel 40 is illustrated which includes an alternative arrangement of intermittent slits 42. As before, panel 40 includes a domed portion 44 and a peripheral flat flange portion 46 connected by a transition connection 48. The slits 42 are positioned in three consecutive side sections of the flank flange portion 46 of the rupture panel 40 and apertures 43 are provided at the ends of the slits 42. Thus, the slits 42 define three sides of a substantially rectangular blow-out part 49 which is hinged to the remaining part of the rupture panel 40 by the unslit fourth side. Rupture tabs 45 are formed between the apertures 43, the strengths of which can be readily reduced by enlarging the apertures 43.

The rupture panel 50 illustrated in Figure 7 includes a domed portion 54 connected to a peripheral flange portion 56 by a transition connection 58. Truncated V-shaped slits 52 are positioned with their truncated parts lying within the domed portion 54 of the rupture panel 12 adjacent the transition connection 58. The side parts of the slits 52 forming the V-shapes extend to positions within the flat flange portion 56 of the rupture disk 12 where flexing brought about by pressure-vacuum cycles is minimized thereby minimizing the deterioration of the rupture panel 50 and the weakening of the rupture tabs 53 formed therein between the slits 52.

Referring now to Figure 8, a rupture panel 60 is illustrated having a domed portion 62 connected to a peripheral flange portion 64 by a transition connection 66. A single continuous slit 68 is formed in the domed portion 62 of the rupture panel 60 adjacent three consecutive sections of the peripheral flange portion 64 thereof, whereby a substantially rectangular hinged blow-out part 70 is formed. Instead of rupture tabs formed integrally in the rupture panel 60 by intermittent slits, separate connector type rupture tabs 72 are attached to the rupture panel 60, such as by spot welds 73, across the slit 68 at intervals therealong, whereby the hinged blow-out part 70 is connected to the remaining part of the rupture panel 60 by the tabs 72. The strengths of the tabs 72 can be controlled using various techniques such as by forming apertures 75 therein. Also wires or other types of spot welded connectors can be substituted for the tabs 72.

The rupture panel 80 illustrated in Figures 9 and 10 has a domed portion 82 connected to a peripheral flange portion 84 by a transition connection 86. A single continuous slit 88 is formed in the domed portion 82 of the rupture panel 80 adjacent three consecutive sections of the peripheral flange portion 84 thereof whereby a substantially rectangular hinged blow-out part 90 is formed. The rupture panel 80 includes a back-up strip 92 spot welded to the previously mentioned three consecutive sections of the peripheral flange portion 84 by a plurality of spot-welds 94. The back-up strip 92 extends over the continuous slit 88 and conforms in configuration to the transition connection 86 and domed portion 82 of the rupture panel 80. A plurality of rivets 96 extend through aligned openings in the back-up strip 92 and domed portion 82 of the rupture panel 80 at intervals therealong, whereby the hinged blow-out part 90 is connected to the remaining part of the rupture panel 80 by the rivets 96. The strengths of the rivets 96 which function as rupture tabs, can be varied by changing the size thereof, determine the particular pressure differential at which the rupture panel 80 will open. As

shown in Figure 10, gasket members 98 and 100 cover the slit 88, the rivets 96 and the strip 92.

Pressure relief panel assemblies including the rupture panels 40, 50, 60 and 80 operate in the same manner as the assembly 10 described above. That is, the rupture tabs 45, 53, 72 and 96 respectively rupture when pressure differentials of predetermined magnitudes are exerted on the rupture panels 40, 50, 60 and 80. The rupture of the rupture tabs allows the hinged blow-out parts of the panels to open and fluid pressures to be relieved therethrough.

### Claims

1. A pressure relief panel assembly comprising a rupture panel (12, 40, 50, 60, 80) having a domed portion (14, 44, 54, 62, 82) connected to a peripheral flat flange portion (16, 46, 56, 64, 84) and having at least one slit (20, 42, 52, 68, 88) formed therein defining a hinged blow-out part (22, 49, 70, 90) in said rupture panel, said hinged blow-out part being connected to the remaining part of said rupture panel by an unslit hinge area (24) and by a plurality of rupture tabs (21, 45, 53, 72) which rupture and allow said hinged blow-out part to open when a pressure differential of predetermined magnitude is exerted on said rupture panel; a pair of gasket members (26, 28, 98, 100) positioned on opposite sides of said peripheral flange portion of said rupture panel and extending inwardly over said at least one slit whereby said at least one slit is sealed by said gasket members when fluid pressure differentials are exerted on said panel; and inlet and outlet complementary rupture panel support members (30, 32) adapted to be sealingly clamped together with said peripheral flange portion of said rupture panel and said gasket members therebetween, and adapted to be sealingly connected over a pressure relief vent.
2. An assembly according to claim 1, characterised in that said hinged blow-out part (22, 49) is defined by a plurality of intermittent slits (20, 42) formed in said rupture panel, and said rupture tabs are comprised of the unslit portions (21, 45) of said panel between said intermittent slits.
3. An assembly according to claim 2, characterised in that apertures (43) are formed in said panel at the ends of said intermittent slits (42).
4. An assembly according to claim 1, characterised in that said hinged blow-out part (70, 90) is defined by a single slit (68, 88) and said

rupture tabs are comprised of separate connectors (72, 42) attached to said blow-out part and to said remaining part of said rupture panel.

5. An assembly according to claim 4, characterised in that said separate connectors comprise a back-up strip (42) extending over said slit (88), a plurality of rivets (96) connecting said back-up strip to said domed part (82) and a plurality of spot-welds (94) connecting said back-up strip to said flange portion (86).
6. An assembly according to any preceding claim, characterised in that said rupture panel, said hinged blow-out part and said inlet and outlet rupture panel support members are all of substantially rectangular shapes.
7. An assembly according to any preceding claim, characterised in that said gasket members (26, 28, 98, 100) are formed of flexible materials and are bonded to said rupture panel.
8. An assembly according to any preceding claim, characterised in that said domed portion (14, 44, 54, 62, 82) of said rupture panel is connected to the peripheral flange portion thereof by a transition connection (18, 48, 58, 66, 86) and in that said inlet rupture panel support member (30) extends inwardly past said transition connection whereby said transition connection is supported by said inlet support member when reverse pressure differential is exerted on said rupture panel.
9. An assembly according to claim 8, characterised in that said inlet rupture panel support member (30) is positioned on the concave side of said rupture panel.

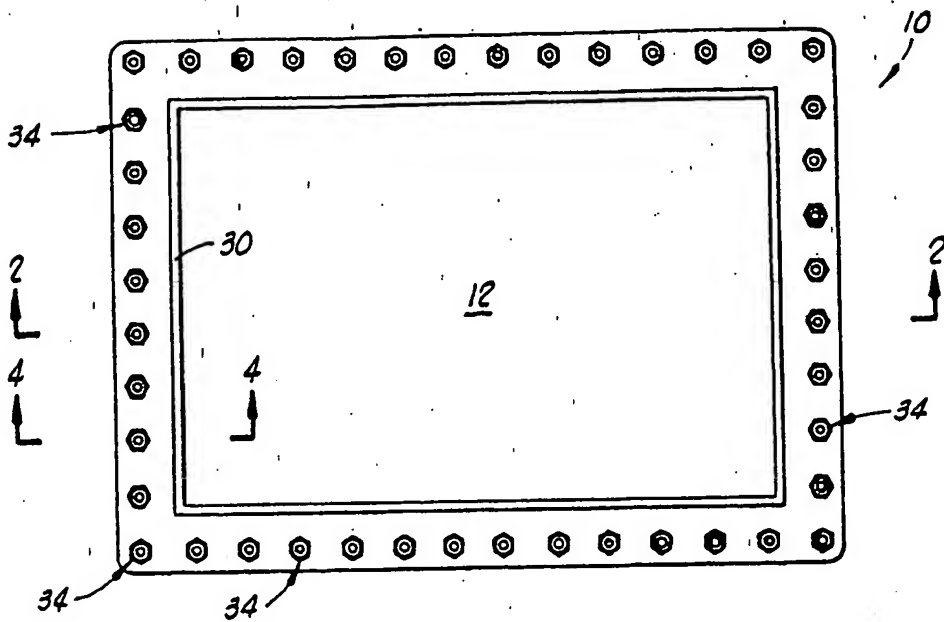


FIG. 1

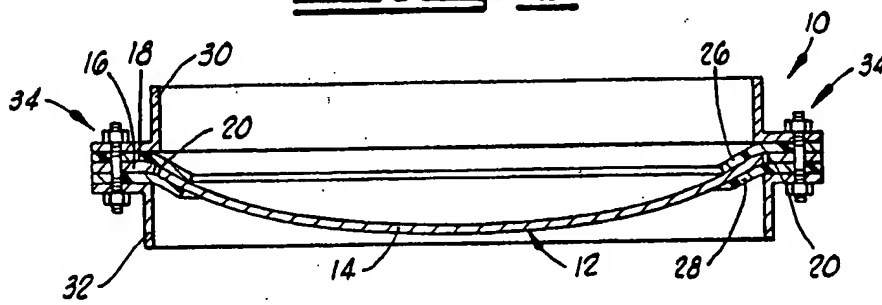


FIG. 2

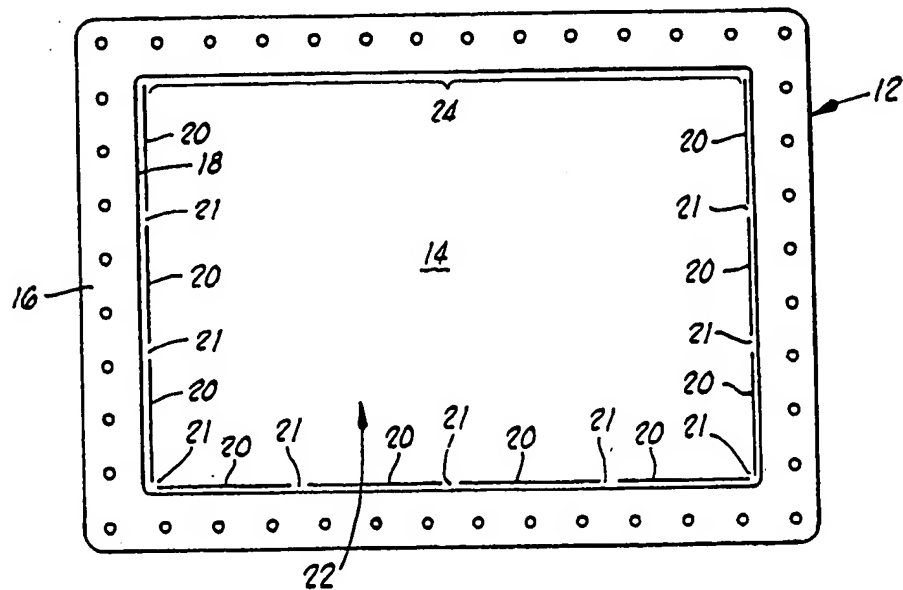
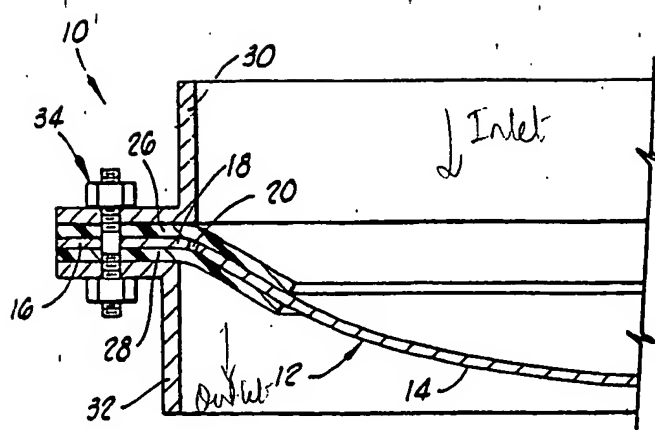
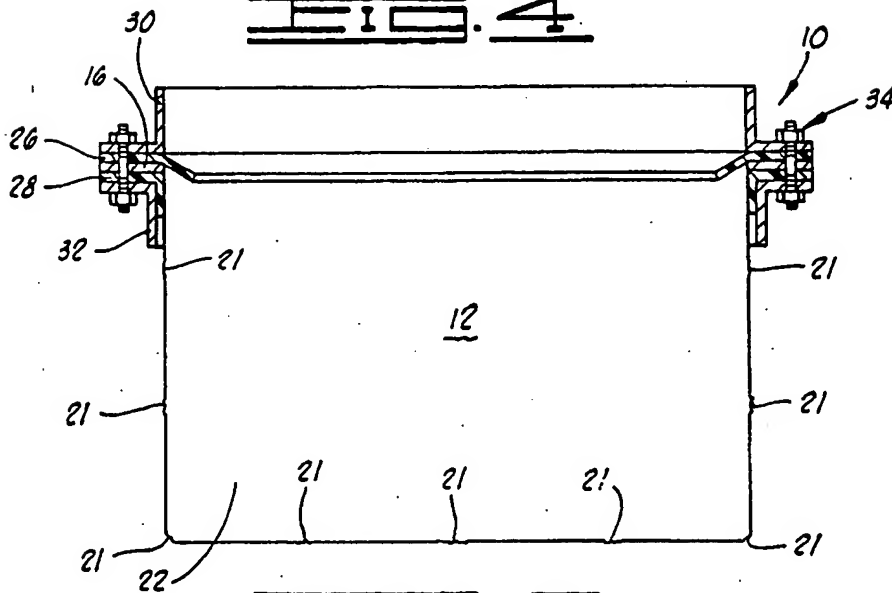


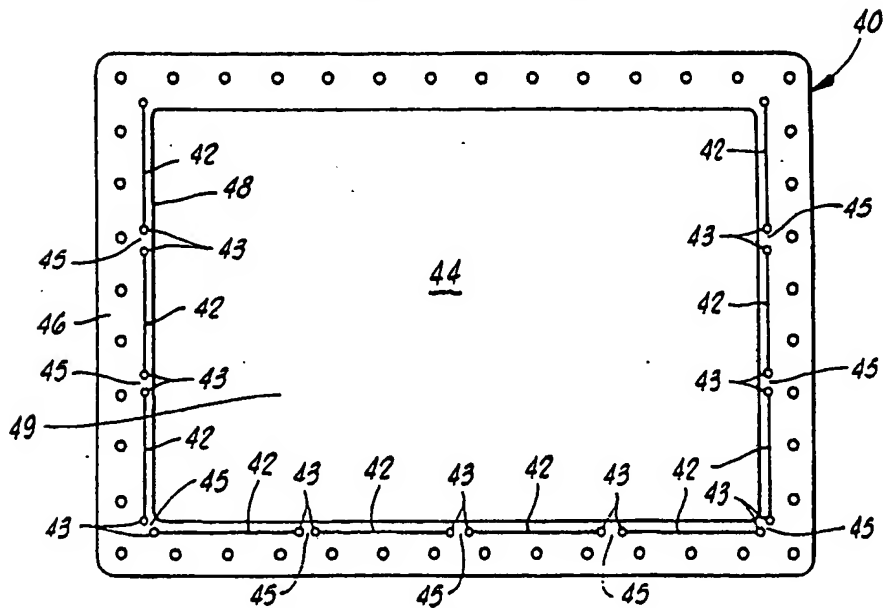
FIG. 3



**FIG. 4**



**FIG. 5**



**FIG. 6**



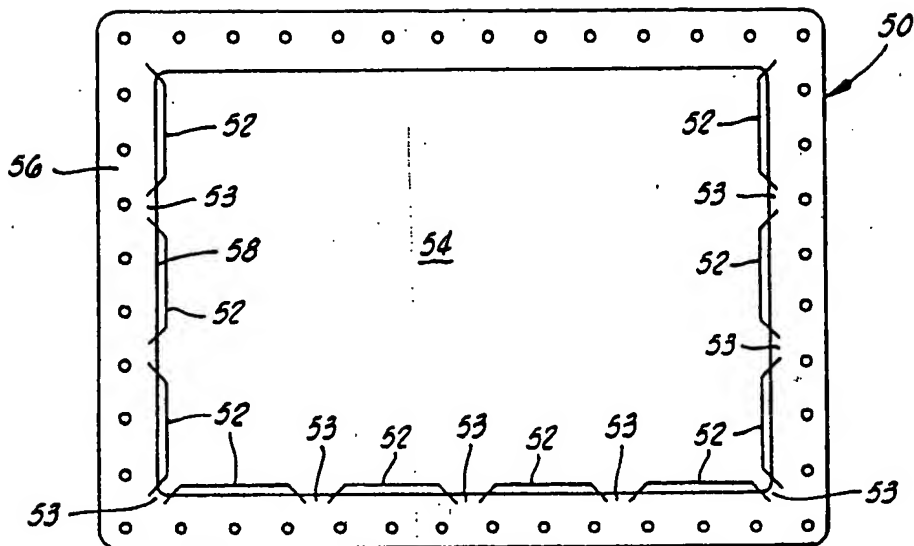


FIG. 7

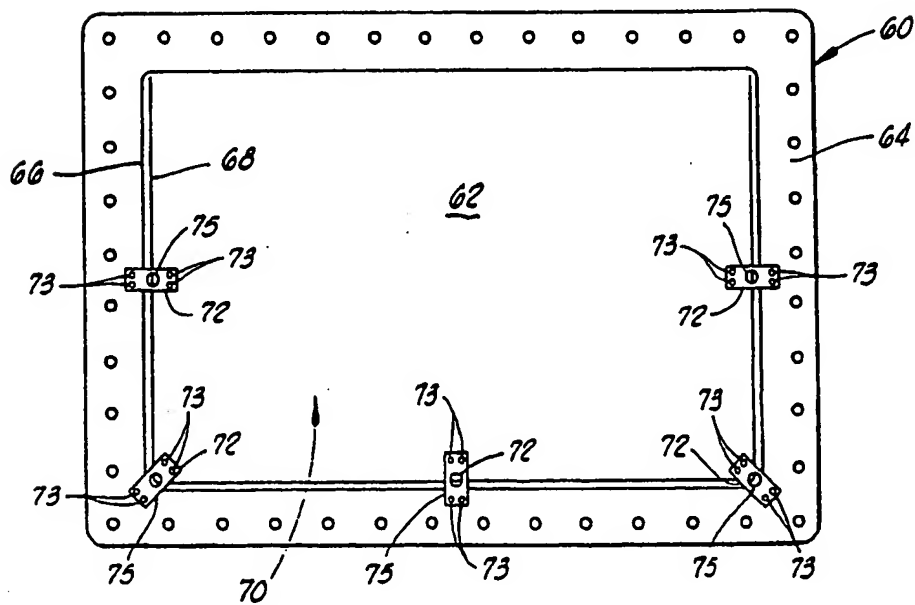


FIG. 8

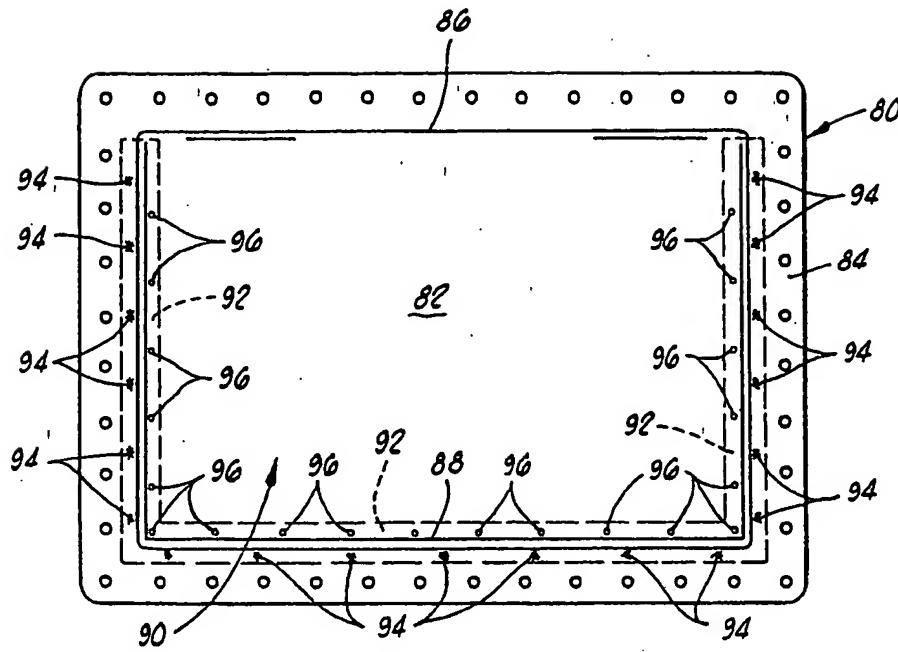


FIG. 9

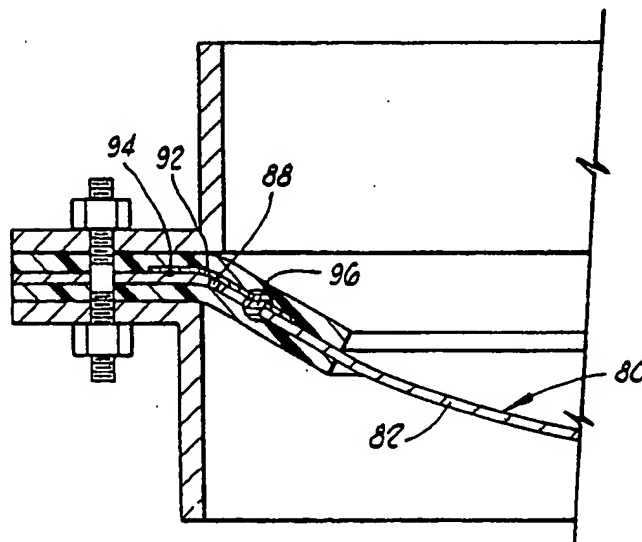


FIG. 10



European  
Patent Office

## EUROPEAN SEARCH REPORT

Application Number

EP 90 31 3783

### DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
D,A	US-A-4 821 909 (DONALD R. HIBLER) * the whole document * ---	1,6	F 16 K 17/16 B 65 D 90/36
A	US-A-4 795 051 (SAM A. OU) * the whole document * ---	1,7,8	
A	EP-A-0 055 909 (ELECTROFABRICATION & ENGINEERING COMPANY) * figures 1-5 * -----	1	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			F 16 K B 65 D
Place of search		Date of completion of search	Examiner
The Hague		24 September 91	OSTYN T.J.M.
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